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ABSTRACT

Data on 174 Colorado school districts were used to measure districts' responses (as indicated by per-pupil expenditures) to their own fiscal capacity and to state aid that changes over time. Colorado's modified guaranteed tax base (GTB) formula was analyzed and a model constructed that took into account the formula's limits on district spending and its year-to-year changes in a district's state aid based on the district's tax revenues in the preceding year. Such changes comprise an "intertemporal price variable." Data were collected on such variables as district wealth (total and residential assessed value), income, state and federal aid, enrollment size and growth, percentage of minority pupils, and agricultural land prices. Using linear and log-linear correlation equations, researchers analyzed the variables' effects on districts' total and locally-derived expenditures and on the elasticity of these expenditures in relation to changes in other variables' values. Results indicate that Colorado's GTB formula has had significant effects neither on differences across districts in expenditures per student nor on the strong correlation between assessed valuation and expenditures. The results also carry implications for the construction of models of districts' fiscal responses. (RW)

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PAPERS IN EDUCATION FINANCE

Paper No.15

"Fiscal Response of School Districts to
District Fiscal Capacity and State Aid"

E. Kathleen Adams and Phillip E. Vincent

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ABSTRACT

Measures of school district response to various external factors and internal financial characteristics have been the focus of a number of recent studies. This paper deals specifically with the Colorado finance scheme. In analyzing Colorado this study departs from previous work in two areas. First the "price" variable of Colorado's formula is defined intertemporally due to the structure of aid disbursement. Secondly, the limits on school district spending are incorporated into the analysis using dummy variables. Conclusions from the work include implications for general modeling of school district response as well as the impacts of Colorado's school finance reform.

INTRODUCTION

The analysis of school district spending for educational services experienced a significant impact with the studies of Feldstein, Ladd, and Grubb & Michelson in the early seventies. With their work, the modeling of school district response models was put to significant empirical testing. The contributions made by these authors include not only a distinction between block grants and matching grants but also a treatment of the impact on spending of measures of local fiscal capacity other than property value.

With issues in education finance still revolving around equity and measures of fiscal capacity, it is imperative to continue to examine empirically the questions these authors addressed. How do districts respond to the distribution of aid from state and federal sources? In particular, how do they react to formulas with a "price" variable? What factors other than assessed value of property affect school district expenditures? These are the types of inquiries that can be answered with the estimation of a fiscal response model.

The investigation, then, of the present study was prompted by these questions and benefited from the theoretical framework of previous authors. Yet, the situation in Colorado does not allow for the simple procedures used in Massachusetts. Although the Colorado formula is a power equalizing one, the particular constraints that were built into it by legislative action, transformed it into what may be termed a "variable foundation" program. Because of these restrictions, the formula does not exhibit matching characteristics except when viewed intertemporally and the analysis of the price effect becomes correspondingly difficult. It may even be argued that the Colorado finance scheme is more the general case than the exception. Of the fifteen states that used a variable guarantee type program in 1975-76,[1] ten of them also had some type of restriction on school district behavior.[2] How to begin dealing with the realities

of these finance structures both in modeling and testing, is an important product of the work done in Colorado.

The Colorado System

With the Finance Reform Act of 1973, Colorado put into effect a modified guaranteed tax base formula. The range of assessed values over which the state would "match" expenditures in inverse relation to assessed value was given an upper limit but a minimum dollar guarantee per mill, per pupil is distributed even to the districts above this level of wealth. Also, the amount of expenditure increases allowed from year to year were set in an inverse relation to the level of expenditures per pupil prevailing in 1973. Those districts spending less than $1,000 per pupil could increase expenditures at rates from 8 to 12 percent per year; but all districts spending at or above $1,000 were allowed increases of only seven percent per year. These limits can be surpassed only by the State School Budget Review Board, or vote of the district. These restrictions feed into the present analysis in two ways, the definition of the price variable of the Colorado formula and the separation of districts into groups to allow for expenditure limit behavior.

The Price Variable

The importance of the above expenditure limits is that they define, in any one year, a school district's Authorized Revenue Base (ARB) which in conjunction with the guaranteed tax base ($27,000 per pupil in 1975) for that year, gives the mill levy on which aid to that district is based. The actual levy of the district does not affect the aid they receive this year -- there is no "matching" of funds. Yet, the level of local revenues raised this year will affect aid received by the district next year. Any matching of state to local funds must be viewed intertemporally in Colorado and a price variable from this formula must include this dynamic aspect.

An intertemporal price variable can be derived from a general algebraic expression for aid per pupil distributed by the guaranteed tax base program in Colorado[3]:

$$A_i = (Gt_s - B_i t_s)$$

where G = state guaranteed valuation per pupil

B_i = assessed valuation of the i^{th} school district

$t_s = (\frac{e'}{G}) * r$

where e' = expenditures by the school district last year

r = allowable growth rate in expenditures from last year

but t_s is <u>not</u> free to vary indiscriminately across districts, rather, its variation is set by the state in relation to the ARB of the district.

Rewriting the above expression and substituting for t_s (no longer expressed in mills):

$$A_i = (G - B_i)\ (\frac{e'}{G}) * r$$

$$= (1 - \frac{B_i}{G}) * e' * r$$

and recognizing that expenditures last year contain a local plus state aid component:

$$A_i = (1 - \frac{B_i}{G})\ (L' + A') * r$$

where L' = locally financed expenditures last year

A' = state equalization aid received last year

To put this formula into the framework of Ladd and Feldstein's price definition, the question that needs to be answered is: What is the relationship of aid dollars and local revenue dollars? That is what additional dollars are forthcoming from the state as local revenues are changed? An answer is found by differentiating the aid expression with respect to the local revenue variable:

$$\frac{\partial A_i}{\partial L'} = (1 - \frac{B_i}{G}) * r$$

The intertemporal price variable then becomes:[3]

$$P_i = \frac{1}{1 + \delta * (\frac{\partial A_i}{\partial L'})} = \frac{1}{1 + \delta * [(1 - \frac{B_i}{G}) * r]}$$

where δ = a discount factor.

The discount factor is needed to take into account the year lag between the action of the district and the receipt of aid.

The price of education expenditures; then, in any given year is less than a dollar of local revenue in that year, by the amount of state to local matching dictated from last year's tax levy. A modified form of this price variable will be used in the expenditure equations.

Modified Intertemporal Price Variable

Although there are various ways to incorporate a price variable into a fiscal response analysis, Ladd and Feldstein were successful in using a simple formulation derived directly from the state aid formula.[5] Other authors, Grubb and Michelson in empirical work and Barro in a broad theoretical work, specify more complex price terms to be used in estimation.[6]

Following the utility-maximizing approach set out by Barro, a modification of the basic model can be made by hypothesizing that only taxes on district residents cause disutility and the percent of assessed valuation that is residential enters into the model in an identical manner as a matching grant in the sense that voting taxpayers perceive their tax dollars as being "matched" by business tax dollars. This modification calls for forming a modified price variable that constrains the impact of the matching of the state aid formula

and the tax base composition to be equivalent. The modified variable, tax price, which appears in the equations is now defined as:

$$\text{Tax Price} = \frac{B_r}{B_i} * P_i$$

where B_r = residential assessed valuation of the school district

Expenditure Limits

As mentioned, the Colorado finance scheme imposed expenditure limits in conjunction with its reform act. These limits, if effective, may actually nullify any "price response" that would otherwise be observed. Such local choice may not really exist in Colorado and other GTB states and the effect of an unrestrained "fiscal price" response is simply not strictly possible.[7]

On the other hand, there are districts which, after review board or district vote approval, behave differently from the dictates of the formula, by levying either above or below the prescribed mill levy. Data on these districts allow for the definition of dummy variables used in the equations. The hypothesis is that these districts by this very behavior are responding to the price variable. An interaction term to allow for differences in the price response among these districts, then, is an important element of the Colorado model. Previous work on the effect of state limits found significant differences between the spending patterns of districts facing limits and those not.[8] Definitions of the dummy variables used are given in Tables 2-6.

Results of Estimated Response Model

Of equal import in the analysis is the relative impacts of other variables on school district spending. The variables used can be categorized as wealth, income, aid and cost variables. Their descriptions, mean value and standard deviations are presented in Table 1. The data are shown for 1975 observations,

TABLE 1

LIST OF VARIABLES

Variable Description	1975 Mean	1975 Standard Deviation	1973, 1975* Mean	1973, 1975* Standard Deviation
Total Current Expenditures Per Pupil	1,583.21	553.99	1,410.33	551.60
Locally Financed Current Expenditures Per Pupil	841.95	483.06	824.38	465.01
State Categorical Aid Per Pupil	235.55	225.46	190.79	186.73
Federal Aid Per Pupil	55.99	68.22	54.55	104.85
Residential Market Value Per Pupil	34,345.38	67,974.75	29,938.36	56,854.99
Adjusted Gross Income Per Return	9,150.12	2,253.19	8,622.67	2,221.55
Pupil Growth Ratio	1.01	.13	1.01	.13
Pupils (1000s)	2.98	8.88	2.99	9.05
Percent Minority Pupils	16.47	19.66	16.25	19.50
Districts Per Square Mile in Region	2.50	1.81	2.50	1.81
Price of Agricultural Land	276.99	793.75	276.99	792.60
Tax Price	20.24	16.42	25.36	21.44

*Pooled Data Set

Sources: Fiscal data were obtained from the Colorado Department of Education. These data include, expenditure and aid variables, pupil-related variables, and adjusted gross income. Data on property value are from Colorado Department of Property Taxation. Data on district per square mile were compiled from: State Economic Areas, 1970 Census of the Population, Washington, D.C. (USGPO), Appendix A, and County and City Data Book, 1972 Washington, D.C. (USGPO), Table 2. Price of Agricultural land was obtained from 1974 Census of Agriculture, County Summary data, Washington, D.C. (USGPO), Table 1.

and for a pooled data set, 1973 and 1975 observations. The final data set used after eliminating districts for which there was missing data on any variable consists of 174 observations for each year.

Expenditure Equation Results

The estimated linear equations for total and local expenditures are shown in Table 2. Obviously, the sign and magnitude of the coefficients for the price variable are not as expected. For both the total and local equations, the measure of the response of school district spending is above $1,000 per pupil for one unit changes in the intertemporal price variable. Although the dummy variable results indicate there is a significant difference in the price coefficient for districts spending above their limit, it is a larger positive number. More reasonable results are obtained using log-form equations.

The aid variables show the expected sign and are, in general, statistically significant. State categorical aid has a stimulative impact on spending in that each additional dollar of state aid in this form is matched by an additional $.50 of local revenue per pupil. The federal aid impact for the 1975 data shows substitution of federal for local funds. That is, only approximately ninety cents out of each dollar of federal aid is spent on education services.

The wealth variable used, total market value shows a consistent impact on spending of approximately $2.00 per pupil for every $1,000 increase in wealth. The coefficient is highly significant statistically. The income variable, an attempt to approximate income per household, is statistically insignificant but its positive impact on spending is the expected result. These equations indicate that for every $1,000 increase in the income of the residents of the district expenditures per pupil increase by approximately $3.

The cost variables used here are an effort to hold costs constant across districts and the results provide much information. Of the cost variables

TABLE 2

TOTAL AND LOCAL EXPENDITURES PER PUPIL
RESPONSE COEFFICIENTS, 1975 — LINEAR EQUATION FORM[a]
INTERTEMPORAL PRICE VARIABLE

Variables	Total	Local
Constant Term ($/pupil)	46.798	—
Intertemporal Price	1,176.109 (3.071)	2,952.480 (8.426)
Dummy Variable One (Intertemporal Price)[b]	110.737 (1.713)	142.032 (2.401)
Dummy Variable Two (Intertemporal Price)[c]	-93.379 (- .984)	7.061 (.081)
State Categorical Aid ($/pupil)	1.578 (13.173)	.598 (5.453)
Federal Aid ($/pupil)	.909 (3.011)	- .056 (- .203)
Total Market Value ($/pupil)	.002 (6.286)	.002 (8.285)
Percent Residential Assessed Value	-1.509 (1.680)	-1.106 (-1.345)
Adjusted Gross Income ($/return)	.003 (.252)	.003 (.308)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)	192.142 (1.365)	137.281 (1.065)
Density (pupils/square mile)	.875 (.509)	.075 (.047)
[illegible]s (1000s)	7.597 (.896)	5.020 (.647)
Pupils Squared (1,000,000s)	- .089 (- .745)	- .059 (- .542)
Percent Minority Pupils	-1.133 (-1.035)	- .463 (- .463)
Districts Per Square Mile in Region (1000s)	31.440 (2.720)	26.[illegible] (2.501)
Price of Agricultural Land ($/acre)	.022 (.636)	.020 (.620)
Highest Teacher Salary ($)	- .011 (- .940)	- .010 (- .947)
R^2	.84	.83

[a]t-statistics are reported in parenthesis. Critical values are 1.96 for 95 percent level of confidence and 1.65 for 90 percent level of confidence, using a two-tailed test.

[b]Dummy Variable One (Intertemporal Price) = Dummy Variable One * Intertemporal Price, where Dummy Variable One = 1, if district spends above 1975 limit; = 0, otherwise.

[c]Dummy Variable Two (Intertemporal Price) = Dummy Variable Two * Intertemporal Price, where Dummy Variable Two = 1, if district spends below 1975 limit; = 0, otherwise.

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used in the equations, measure of pupil density, districts per square mile and the price of agricultural land affect the attractiveness of the district and are considered supply factors. Percent minority pupils and the size of the district, measured by pupils plus pupils squared, are considered technological cost factors. In particular, the existence of economies of scale is tested for by the above mentioned size variables.

The density variable is not significantly different from zero but its positive sign indicates it may be harder to attract teachers to such districts. A second cost variable, districts per square mile,is used as an indicator of the competitiveness of the teacher labor market. Its impact on spending is positive, an additional $26 to $31 of expenditure per pupil, and the coefficient is significant in all equations. As a crude measure of the cost-of-living within the school district, the price of agricultural land exhibits a positive effect on expenditures per pupil of about $2 with increases in the price of land. These variables and results are difficult to put in a policy framework in the sense that they simply characterize a district on factors that may make education more costly to provide.

Two remaining cost variables, the percent minority pupils and the size of district, are pupil-oriented and easier to interpret. The results on percent minority pupils are consistently negative. Although not statistically significant in the linear equations, the coefficient indicates that a one percent increase in minority pupils results in a decrease of approximately $1.00 of total per pupil expenditures. Although a more plausible result would be that it would be harder to attract teachers in districts with higher percent minority or that it would require more resources of all types, and therefore be more costly,[9] the results indicate otherwise. This information adds credence to an argument that minority students are clustered in low-income districts in Colorado and are not being effectively reached by state aid disbursements.

The coefficients on the size of the districts [pupils (1000s) + pupils squared (1,000,000s)] are insignificant and the results in these equations are not consistent with a u-shaped cost curve. The pupil growth ratio, which is the number of pupils in 1975 divided by that number in 1973, has a strong positive impact on spending. Although a lag of expenditure adjustments with an increase in pupils is expected to lead to a negative relationship, the existence of special programs in Colorado to aid high growth districts could nullify this pattern.

A fiscal cost variable, highest teacher salary is statistically insignificant and its simple correlation with income and aid variables is quite high. It is dropped from some of the following equations.

Log-Form Equations

The results of three specifications of double log-form equations are shown in Tables 3-6. The elasticities estimated here and by earlier studies for Massachusetts as well as recent results for Michigan are reported in a table following these

As can be seen in Table 3 the results on the price variable are significantly improved by using the double log-form. Using a statistical test for preference between these two functional forms indicate the double log form is preferable.[10]

The results indicate that the only group exhibiting a significant response to price are those spending above the limit and for them, a one percent change in price results in a .19 percent decrease in total expenditures per pupil. For those districts spending at or below their limits, the price coefficient is not significantly different from zero in the total expenditure equation. For locally financed expenditures per pupil, the price coefficient is positive and statistically significant. This is not an unexpected result and only indicates

TABLE 3

TOTAL AND LOCAL EXPENDITURES PER PUPIL RESPONSE COEFFICIENTS, 1975 — LOG LINEAR EQUATION FORM[a] INTERTEMPORAL PRICE VARIABLE

Variables	Total	Local
Constant Term ($/pupil)	3.022	5.437
Intertemporal Price	.201 (.902)	3.248 (12.397)
Dummy Variable One (Intertemporal Price)[b]	- .193 (2.721)	- .451 (5.407)
Dummy Variable Two (Intertemporal Price)[c]	.130 (.986)	.053 (.340)
State Categorical Aid ($/pupil)	.111 (6.591)	.046 (2.287)
Federal Aid ($/pupil)	.022 (2.622)	- .001 (.108)
Residential Market Value ($/pupil)	.117 (4.244)	.214 (6.568)
Percent Residential Assessed Value	- .155 (4.479)	- .273 (6.720)
Adjusted Gross Income ($/return)	- .056 (1.112)	- .025 (.410)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)	.124 (1.359)	.252 (2.334)
Density (pupils/square mile)	.026 (1.855)	.034 (2.057)
Pupils (1000s)	- .126 (5.770)	- .076 (2.543)
Percent Minority Pupils	- .001 (1.835)	- .002 (2.697)
Districts Per Square Mile in Region (1000s)	.055 (2.112)	- .004 (.125)
Price of Agricultural Land ($/acre)	.057 (2.548)	.067 (2.543)
Highest Teacher Salary ($)	.330 (2.980)	.054 (.411)
R^2	.76	.91

[a] t-statistics are reported in parenthesis. Critical values are 1.96 for 95 percent level of confidence and 1.65 for 90 percent level of confidence, using a two-tailed test.

[b] Dummy Variable One (Intertemporal Price) = Dummy Variable One * Log (Intertemporal Price), where Dummy Variable One = 1, if district spends above 1975 limit; = 0, otherwise

[c] Dummy Variable Two (Intertemporal Price) = Dummy Variable Two * Log (Intertemporal Price), where Dummy Variable Two = 1, if district spends below 1975 limit; = 0, otherwise.

TABLE 4

TOTAL AND LOCAL EXPENDITURES PER PUPIL
RESPONSE COEFFICIENTS, 1975 — LOG LINEAR EQUATION FORM[a]
MODIFIED PRICE VARIABLE

Log of Variables	Total	Local
Constant Term ($/pupil)	5.635	1.633
Tax Price	- .197 (6.500)	- .601 (11.183)
Dummy Variable One (Tax Price)[b]	.035 (3.472)	.061 (3.417)
Dummy Variable Two (Tax Price)[c]	- .005 (.285)	- .024 (.779)
State Categorical Aid ($/pupil)	.117 (6.741)	.086 (2.808)
Federal Aid ($/pupil)	.023 (2.764)	- .007 (.461)
Residential Market Value ($/pupil)	.144 (5.901)	.474 (10.941)
Adjusted Gross Income ($/return)	- .026 (.496)	.089 (.963)
Density (pupils/square mile)	.032 (2.252)	.028 (1.123)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)[d]	.062 (.660)	.124 (.742)
Pupils (1000s)	- .094 (5.156)	- .102 (3.159)
Percent Minority Pupils[d]	- .002 (3.491)	- .007 (5.572)
Districts Per Square Mile in Region (1000s)	.049 (1.830)	- .003 (.069)
Price of Agricultural Land ($/acre)	.052 (2.304)	.106 (2.665)
R^2	.74	.77

[a]t-statistics are reported in parenthesis. Critical values are 1.96 for 95 percent level of confidence and 1.65 for 90 percent level of confidence, using a two-tailed test.

[b]Dummy Variable One (Tax Price) = Dummy Variable One * Log (Tax Price), where Dummy Variable One = 1, if district spends above 1975 limit; = 0, otherwise.

[c]Dummy Variable Two (Tax Price) = Dummy Variable Two * Log (Tax Price), where Dummy Variable Two = 1, if district spends below 1975 limit; = 0, otherwise.

[d]Not in log form.

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TABLE 5

TOTAL AND LOCAL EXPENDITURES PER PUPIL RESPONSE COEFFICIENTS, POOLED DATA — LOG LINEAR EQUATION FORM[a] INTERTEMPORAL PRICE VARIABLE

Log of Variables	Total	Local
Constant Term ($/pupil)	1.775	-3.274
Intertemporal Price	- .255 (4.611)	.673 (7.892)
Dummy Variable One (Intertemporal Price)[b]	- .123 (1.804)	- .287 (2.742)
Dummy Variable Two (Intertemporal Price)[c]	.131 (.977)	.138 (.668)
State Categorical Aid ($/pupil)	.119 (8.958)	.107 (5.217)
Federal Aid ($/pupil)	.030 (4.985)	- .002 (.233)
Residential Market Value ($/pupil)	.153 (9.706)	.387 (15.924)
Percent Residential Assessed Value	- .200 (10.180)	- .478 (15.815)
Adjusted Gross Income ($/return)	- .033 (.929)	.086 (1.561)
Density (pupils/square mile)	.028 (2.724)	.032 (1.976)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)[d]	.182 (2.713)	.342 (3.307)
Pupils (1000s)	- .123 (7.884)	- .141 (5.847)
Percent Minority Pupils[d]	- .002 (3.93[illegible]	- .005 (5.[illegible])
Districts Per Square Mile in Region (1000s)	.052 (2.723)	.020 (.680)
Price of Agricultural Land ($/acre)	.051 (3.158)	.081 (3.232)
Highest Teacher Salary ($)	.391 (5.098)	.604 (5.107)
R^2	.77	.80

[a] t-statistics are reported in parenthesis. Critical values are 1.65 for 95 percent level of confidence and 1.30 for 90 percent level of confidence.

[b] Dummy Variable One (Intertemporal Price) = Dummy Variable One * Log (Intertemporal Price), where Dummy Variable One = 1, if district spends above 1975 limit; = 0, otherwise.

[c] Dummy Variable Two (Intertemporal Price) = Dummy Variable Two * Log (Intertemporal Price), where Dummy Variable Two = 1, if district spends below 1975 limit; = 0, otherwise.

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TABLE 6

TOTAL AND LOCAL EXPENDITURES PER PUPIL RESPONSE COEFFICIENTS, POOLED DATA — LOG LINEAR EQUATION FORM[a] MODIFIED PRICE VARIABLE

Log of Variables	Total	Local
Constant Term ($/pupil)	1.721	.951
Tax Price	- .202 (10.470)	- .393 (10.[illegible]3)
Dummy Variable One (Tax Price)[b]	.022 (2.635)	- .027 (1.700)
Dummy Variable Two (Tax Price)[c]	- .006 (.370)	- .069 (2.137)
State Categorical Aid ($/pupil)	.120 (9.050)	.088 (3.420)
Federal Aid ($/pupil)	.029 (4.927)	- .0[illegible]2 (1.032)
Residential Market Value ($/pupil)	.153 (9.698)	.326 (10.654)
Adjusted Gross Income ($/return)	- .028 (.787)	- .029 (.424)
Density (pupils/square mile)	.030 (2.[illegible]5)	.027 (1.362)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)[d]	.186 (2.780)	.195 (1.504)
Pupils (1000s)	- .124 (7.943)	- .116 (3.837)
Percent Minority Pupils[d]	- .002 (3.773)	- .007 (7.266)
Districts Per Square Mile in Region (1000s)	.052 (2.720)	.000 (.008)
Price of Agricultural Land($/acre)	.047 (2.909)	.126 (4.056)
Highest Teacher Salary ($)	.395 (5.215)	.289 (1.973)
R^2	.77	.69

[a]t-statistics are reported in parenthesis. Critical values are 1.65 for 95 percent level of confidence and 1.30 for 90 percent level of confidence.

[b]Dummy Variable One (Tax Price) = Dummy Variable One * Log (Tax Price), where Dummy Variable One = 1, if district spends above 1975 limit; = 0, otherwise.

[c]Dummy Variable Two (Tax Price) = Dummy Variable Two * Log (Tax Price), where Dummy Variable Two = 1, if district spends below 1975 limit; = 0, otherwise.

[d]Not in log form.

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that districts tend to spend more on all goods (decrease for tax revenues) as the price of education services is reduced. Again. those districts spending above the limit exhibit a slightly different elasticity, there is less of a tendency to reduce taxes in those districts.

The remaining elasticities in Table 3 are consistent with those in Table 2. There is no improvement in the income results but all cost variables appear statistically significant in these equations. One highly significant coefficient is that of percent residential assessed valuation in both total and local expenditures. It exhibits the expected inverse relation to expenditures and is close in value to the intertemporal price variable for total expenditures.

Constrains these two effects to be equal the specification in Tables 4 and 6 shows interesting results, which can be compared to those on the intertemporal price variable. The modified price variable is negative in both total and local equations and statistically significant. There are no major changes in the elasticity measures for other variables. The primary difference in the results is the negative coefficient for this price term in the local expenditure equation as opposed to the results in Table 5. There, the intertemporal price term estimated on the pooled data set as in Table 6, indicates a difference from the results of Table 3 in that the price coefficient is statistically significant for all groups but, again, positive in the local expenditure equation.

To reconcile these results, an F-test can be used to determine the appropriate specification of price (intertemporal or modified). When performed, the F-statistic indicated that the null hypothesis that these two price effects are equal is accepted in the total expenditure equation but rejected at the .01 level of confidence in the local expenditure equation. This follows, of course, since the intertemporal price tends to have a positive relationship to

local revenues percent residential is consistently negative. These results corrobarate Grubb and Michelson's argument that since the price elasticity of local revenue due to the matching rate is .218 and the elasticity with respect to percent residential is -.134 it is inappropriate to use one measure of price response as a substitute for the other.[11]

Since the variations in local expenditures are those leading to inequalities originally, and since no information is lost by the specification used in Table 5, it is this specification of the price term that is considered 'appropriate' for Colorado.

Relative Elasticities

The elasticities of selected variables from these equations and those of other authors are presented in Table 7. There is considerable difference in the elasticity estimates for Colorado and Michigan as compared to Massachusetts but some fall within a comparable range when estimates by all authors are considered.

In general, the state aid elasticities are higher for Colorado, the lowest for Colorado being .11 and for Massachusetts .03. It must be noted, however, that the state aid variable in Massachusetts only includes equalization aid that is non-matching. State categorical aid is included in the Massachusetts federal aid variable, for which the elasticity estimates are higher than those of Colorado. The highest Colorado elasticity for the federal aid variable equals .03 as compared to .21 in the Massachusetts studies.

Wealth elasticities, those reflecting the property value measures, are very similar between Michigan and Colorado but, in general, lower than Massachusetts. The elasticity of total expenditures to wealth in Colorado is in the range of .12 to .15 and for local expenditures, .21 to .47. For Massachusetts, the corresponding range is .10 to .36 for total, and .40 for local expenditures.

TABLE 7

SELECTED VARIABLES OF SCHOOL DISTRICT FISCAL RESPONSE --
RANGES OF ESTIMATED ELASTICITIES OF EXPENDITURE PER PUPIL CHANGES[a]

	Michigan	Massachusetts		
	Total Expenditures	Total Expenditures		Local Expenditures
	Carroll	Ladd	Feldstein	Grubb and Michelson
State Aid	.03	.03 to .04	-.07 to .13	-.01
Federal Aid	.02 to .03	.11	.03 to .21	.64
"Price" of State Aid	-.03	-.59 to -.49	-1.60 to-.94	.14
Tax Price	-.05 to -.02	-.65	NA	NA
Property Value	.07 to .12	.24 to .29	.10 to .36	.40
Income	.08 to .09	.41 to .46	.15 to .64	.82
Percent Residential	-.05 to -.02	-.31	-.15 to-.06	-.13

	Colorado	
	Total Expenditures	Local Expenditures
State Aid	.11 to .12	.05 to .11
Federal Aid	.02 to .03	-.001 to -.012
Intertemporal Price[b]	-.26	.67 to 3.25
Group One	-.37 to -.19	.39 to 2.79
Tax Price (Modified)	-.20 to -.19	-.60 to -.39
Group One	-.18 to -.16	-.54 to -.42
Property Value	.12 to .15	.21 to .47
Income	-.03 to -.05	-.02 to .09
Percent Residential	-.20 to -.15	-.47 to -.27

[a]Elasticities are defined as the percent change in the dependent variable with a one percent change in the independent variable

[b]Only those price coefficients that are statistically significant and estimated by equations using residential market value are reported here.

Source: Helen F. Ladd, "Local Education Expenditures, Fiscal Capacity and the Composition of the Property Tax Base," National Tax Journal 28 (June 1975):145-58; Martin S. Feldstein, "Wealth Neutrality and Local Choice in Public Education," American Economic Review 65 (March 1975):75-89; W. Norton Grubb and Stephen Michelson, States and Schools: The Political Economy of School Finance. Lexington Mass.: Lexington Books, 1974; Stephen J. Carroll, "Analysis of Time Sereis Cross-Section Data on Michigan School District Expenditur Behavior," Paper presented at the Western Economics Association Meetings, Honolulu, Hawaii, June 1978.

An important difference in the elasticity estimates is that on income measures. The income elasticities estimated for Colorado are low and statistically insignificant in most equations. For Colorado, the only positive income elasticity is .09 for local expenditures as opposed to .82 as estimated by Grubb and Michelson for Massachusetts. Results for Michigan are positive but, again, much lower than Massachusetts.

The price elasticities can really only be compared across authors for "price" of state aid and intertemporal price since tax price is defined somewhat differently by all authors. Obviously the price elasticity estimates for Massachusetts are much greater than those for Colorado or Michigan. The lative impact on education expenditures appears to be much greater in Massachusetts. The observation that the local expenditure price elasticity for Colorado is higher than the one estimate given for Massachusetts indicates Colorado's districts are far more likely to reduce taxes in response to the price of matching aid.

A final comparison that can be made is that of the elasticity associated with percent residential assessed property. The inverse relationship of this variable with local spending is much stronger in Colorado (-.47) than Massachusetts (-.13).

Conclusions and Policy Implications

The conclusions of the Colorado analysis can be discussed within three areas. First, there are implications of these results for the objectives of reform in Colorado and for the general goals of equity in the provision of education resources. Secondly, the information on the relative size of elasticities of spending can be used in discussing potential, broader measures of fiscal capacity. Finally, only the success of only an intertemporal price variable and necessity of dummy variables to account for expenditure limits

indicates the simple modeling used in Massachusetts may not be operational in other states.

Objectives of Reform

The intended reform of Colorado's 1973 act loses impact on three counts. The first is that the pattern of spending inequalities was tied to that existing in 1973 which inevitably were strongly related to property values, and the minimum guarantee of the formula gives state equalization aid even to the richest districts. Secondly, the constraints on school district spending disallows voluntary additional local spending in response to price without political procedures. Finally the Colorado formula, as any formula which emphasizes the simple standard of property wealth neutrality, ignores other components of fiscal capacity which add to spending differentials across districts.

Although the reform has resulted in lower tax levies for most school districts it has not significantly impacted the differences in expenditures per pupil nor the strong positive relationship of assessed valuation and expenditures per pupil. The simple correlation of total assessed valuation and total expenditures per pupil equaled .89 in 1973 and dropped slightly to .81 in 1975. A measure of the variance of expenditures per pupil across districts, the coefficient of variation shows a slight drip, .35 from .40. The minimum total expenditures per pupil was raised from $691 per pupil to $955 per pupil, which appears to be the real objective of the Colorado reform act -- to raise the level of spending in all districts but allow significant differences across districts. Part of these differentials, of course, are cost-related.

The results of the present study indicate that the price incentive of the formula are effective even in the constrained environment and could,

perhaps, be used as a more powerful policy tool if legislatures gauged the magnitude of responses by districts. They should also recognize the differential responses that are taking place under the existing system when districts choose to exceed their spending limits.

Broadening Fiscal Capacity

The advantage of regression analysis is to give insight into the behaviorial parameters that describe a district's ability and willingness to obtain tax revenues for educational expenditures. A decision maker may wish to incorporate this knowledge in formulas which compensate districts inversely to their fiscal capacity. Wealth, income and tax base composition are the three major components of fiscal capacity theorized and tested. The relative weightings of these three in any given state are observable through statistical analysis. For Colorado, the data suggests careful consideration of the tax base composition, especially in conjunction with the price effects of Colorado's formula. The inability to obtain significant estimates for the income measure used here may indicate it is not as important in Colorado as other states. Better data along with further analysis should be carried out before such a conclusion is drawn. The only statistically significant coefficient in the present equations was positive.

Estimation of Price Elasticity

Having had to depart from the general framework of Feldstein in deriving a price variable for Colorado and the difficulties in obtaining reasonable results indicate that the procedures followed by Feldstein and others will not provide the needed information in many cases. Feldstein himself notes this problem:[12]

> "If the matching rate varies sufficiently and is not highly correlated with the other explanatory variables, the possiblity of under identification is not likely to be a problem of practical significance. The Massachusetts experience is a good illustration."

Yet, the precision with which Feldstein implies policy makers can achieve "any desired degree of wealth neutrality" begs the question of the ability to obtain estimates of such "price" elasticities. Even if such estimates are derived, the insignificant magnitude of such elasticities as Carroll's have a very different implication for policy than those of Feldstein's. Much further research on the stability of such parameters across time as well as states is needed before manipulation of the price term as suggested by Feldstein is seriously suggested to state legislators.

FOOTNOTES

1. A variable guarantee program includes those using percentage equalizing, guaranteed yield and guaranteed tax base programs. For data on states using each form, see Tron [9], Table 1.

2. For data on restrictions in all states see Wilken and Callahan [12].

3. This expression is modified to describe the Colorado finance scheme. For a full discussion of state school aid formulas and their equivalance see Jargowsky, Moskowitz and Simkin [7].

4. A more formal derivation of this price variable is given in unpublished dissertation. See E. Kathleen Adams [1].

5. For a detailed treatment of the derivation of their price variable see E. Kathleen Adams [1].

6. See Grubb and Michelson [5] and Barro [3] for further discussion.

7. For results and discussion of these findings see Vincent and Adams [11].

8. In particular the income elasticities were hypothesized as significantly different and empirical work confirmed this. See ACIR [2].

9. A recent study by Grubb and Osman [6] indicates a positive impact on expenditures per pupil from higher percentage black pupils.

10. A procedure for testing the two functional forms is given by Maddala [9].

11. For a thorough presentation of their results, see Grubb and Michelson [5].

12. Feldstein states that any degree of wealth neutrality, as well as stimulation of consumption of education can be brought about if decision makers set the price of a matching grant formula in a precise relation to wealth, given measures of behaviorial parameters. See Feldstein [4] for further discussion.

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